Amendments in the claims:

1. (original) A multi-channel optical frequency mixer for all-optical signal processing comprising:

a) a nonlinear optical material having an effective nonlinearity d_{eff};

b) a quasi-phase-matching grating defining a spatial distribution of said effective nonlinearity d_{eff} in said nonlinear optical material, such that a Fourier transform of said spatial distribution to the spatial frequency domain defines at least two short wavelength channels quasi-phase-matched for performing optical frequency mixing.

2. (original) The multi-channel optical frequency mixer of claim 1, wherein said Fourier transform of said spatial distribution comprises at least two dominant Fourier components corresponding to said at least two short wavelength channels.

3. (original) The multi-channel optical frequency mixer of claim 2, wherein said Fourier transform of said spatial distribution comprises an even number of said dominant Fourier components.

4. (original) The multi-channel optical frequency mixer of claim 2, wherein said Fourier transform of said spatial distribution comprises an odd number of said dominant Fourier components.

5. (original) The multi-channel optical frequency mixer of claim 2, wherein said quasi-phase-matching grating has predetermined

grating parameters for producing said at least two dominant Fourier components.

6. (original) The multi-channel optical frequency mixer of claim 5, wherein said predetermined grating parameters are selected from the group consisting of grating periods, phase reversal sequences and duty cycles.

7. (original) The multi-channel optical frequency mixer of claim 5, wherein said grating has a uniform grating period superposed by a phase reversal sequence.

8. (original) The multi-channel optical frequency mixer of claim 7, wherein said phase reversal sequence has a predetermined duty cycle.

9. (original) The multi-channel optical frequency mixer of claim 2, wherein said quasi-phase-matching grating further comprises a chirp.

10. (original) The multi-channel optical frequency mixer of claim 2, further comprising optical structures for in-coupling and out-coupling light into and out of said quasi-phase-matching grating.

11. (original) The multi-channel optical frequency mixer of claim 1, further comprising at least one waveguide.

12. (original) The multi-channel optical frequency mixer of claim 11, wherein said quasi-phase-matching grating is distributed within said at least one waveguide.

13. (original) The multi-channel optical frequency mixer of claim 11, further comprising a mode controlling structure.

14. (currently amended) The multi-channel optical frequency mixer of claim 1, wherein said nonlinear optical material comprises a substrate having at least one component selected from the group consisting of lithium niobate, lithium tantalate, $MgO:LiNbO_3$, $Zn:LiNbO_3$, $MgO:LiTaO_3$, stoichiometric lithium niobate, stoichiometric lithium tantalate, potassium ~~potasium~~ niobate, KTP, KTA, RTA, RTP and members of the III-V semiconductor family.

15. (original) The multi-channel optical frequency mixer of claim 14, further comprising a waveguide in or on said substrate.

16. (original) The multi-channel optical frequency mixer of claim 15, wherein said waveguide is an in-diffused waveguide.

17. (original) The multi-channel optical frequency mixer of claim 1, further comprising a polarization control system for

rendering said multi-channel optical frequency mixer polarization diverse.

18. (original) The multi-channel optical frequency mixer of claim 17, wherein said polarization control system comprises at least one element selected from the group consisting of polarization mode separator, polarization rotator, optical isolator, optical circulator, optical fiber, polarization maintaining fiber and polarization controller.

19. (original) A method of all-optical signal processing using multi-channel optical frequency mixing comprising:

a) providing a nonlinear optical material having an effective nonlinearity d_{eff};

b) defining a spatial distribution of said effective nonlinearity d_{eff} in said nonlinear optical material with a quasi-phase-matching grating, such that a Fourier transform of said spatial distribution to the spatial frequency domain defines at least two short wavelength channels quasi-phase-matched for performing optical frequency mixing.

20. (original) The method of claim 19, wherein said Fourier transform of said spatial distribution is defined to have at least two dominant Fourier components corresponding to said at least two short wavelength channels.

21. (original) The method of claim 20, wherein said Fourier transform of said spatial distribution is defined to have an even number of said dominant Fourier components.

22. (original) The method of claim 20, wherein said Fourier transform of said spatial distribution is defined to have an odd number of said dominant Fourier components.

23. (original) The method of claim 20, wherein said quasi-phase-matching grating has predetermined grating parameters, and said method further comprises setting said predetermined grating parameters to produce said at least two dominant Fourier components.

24. (original) The method of claim 23, wherein said predetermined grating parameters are selected from the group consisting of grating periods, phase reversal sequences and duty cycles.

25. (original) The method of claim 24, wherein said grating periods are selected to define the location of said at least two dominant Fourier components.

26. (original) The method of claim 20, further comprising providing a chirp in said quasi-phase-matching grating.

27. (original) The method of claim 20, further comprising apodizing said dominant Fourier components to eliminate higher harmonics.

28. (original) The method of claim 19, further comprising in-coupling and out-coupling light into and out of said quasi-phase-matching grating.

29. (original) The method of claim 19, wherein said optical frequency mixing comprises at least one mixing operation selected from the group consisting of second harmonic generation, difference frequency generation, sum frequency generation, and parametric amplification.

30. (original) The method of claim 19, wherein said optical frequency mixing comprises a cascaded optical frequency mixing.

31. (original) The method of claim 19, wherein light comprising at least two long wavelength beams is in-coupled into said quasi-phase-matching grating and said optical frequency mixing is performed simultaneously on said at least two long wavelength beams.

32. (currently amended) A method for engineering a multi-channel optical frequency mixer comprising:

a) providing a non-linear optical material having an effective nonlinearity d_{eff};

b) determining at least two short wavelength channels; and

c) producing a quasi-phase-matching grating in said non-linear optical material to define a spatial distribution of said effective nonlinearity d_{eff}, such that said at least two short wavelength channels are quasi-phase-matched for performing optical frequency mixing~~.~~;

wherein said quasi-phase-matching grating is produced by selecting a Fourier transform of said spatial distribution to the spatial frequency domain to define at least two dominant Fourier components corresponding to said at least two short wavelength channels.

33. (canceled)

34. (currently amended) The method of claim 32 ~~33~~, wherein said selecting is performed by setting at least one parameter of said quasi-phase-matching grating selected from the group consisting of grating period, phase reversal sequence, and duty cycle.

35. (currently amended) A multi-channel optical frequency mixer produced by the method of claim 32 ~~33~~.

36. (original) A multi-channel optical frequency mixer for all-optical signal processing using at least two long wavelength beams, said multi-channel optical frequency mixer comprising:

a) a nonlinear optical material having an effective nonlinearity d_{eff};

b) a quasi-phase-matching grating defining a spatial distribution of said effective nonlinearity d_{eff} in said nonlinear optical material, such that a Fourier transform of said spatial distribution to the spatial frequency domain defines at least two short wavelength channels quasi-phase-matched for performing optical frequency mixing.

37. (original) The multi-channel optical frequency mixer of claim 36, wherein said Fourier transform of said spatial distribution comprises at least two dominant Fourier components corresponding to said at least two short wavelength channels.

38. (original) The multi-channel optical frequency mixer of claim 37, wherein said Fourier transform of said spatial distribution comprises an even number of said dominant Fourier components.

39. (original) The multi-channel optical frequency mixer of claim 37, wherein said Fourier transform of said spatial distribution comprises an odd number of said dominant Fourier components.

40. (original) The multi-channel optical frequency mixer of claim 37, wherein said quasi-phase-matching grating has predetermined grating parameters for producing said at least two dominant Fourier components.

41. (original) The multi-channel optical frequency mixer of claim 40, wherein said predetermined grating parameters are selected from the group consisting of grating periods, phase reversal sequences and duty cycles.

42. (original) The multi-channel optical frequency mixer of claim 40, wherein said grating has a uniform grating period superposed by a phase reversal sequence.

43. (original) The multi-channel optical frequency mixer of claim 42, wherein said phase reversal sequence has a predetermined duty cycle.

44. (original) The multi-channel optical frequency mixer of claim 37, wherein said quasi-phase-matching grating further comprises a chirp.

45. (original) The multi-channel optical frequency mixer of claim 37, further comprising optical structures for in-coupling and out-coupling light into and out of said quasi-phase-matching grating.

46. (original) The multi-channel optical frequency mixer of claim 36, further comprising at least one waveguide.

47. (original) The multi-channel optical frequency mixer of claim 46, wherein said quasi-phase-matching grating is distributed within said at least one waveguide.

48. (original) The multi-channel optical frequency mixer of claim 46, further comprising a mode controlling structure.

49. (currently amended) The multi-channel optical frequency mixer of claim 36, wherein said nonlinear optical material comprises a substrate having at least one component selected from the group consisting of lithium niobate, lithium tantalate, $MgO:LiNbO_3$, $Zn:LiNbO_3$, $MgO:LiTaO_3$, stoichiometric lithium niobate, stoichiometric lithium tantalate, potassium ~~potasium~~ niobate, KTP, KTA, RTA, RTP and members of the III-V semiconductor family.

50. (original) The multi-channel optical frequency mixer of claim 49, further comprising a waveguide in or on said substrate.

51. (original) The multi-channel optical frequency mixer of claim 50, wherein said waveguide is an in-diffused waveguide.

52. (original) The multi-channel optical frequency mixer of claim 36, further comprising a polarization control system for rendering said multi-channel optical frequency mixer polarization diverse.

53. (original) The multi-channel optical frequency mixer of claim 52, wherein said polarization control system comprises at least one element selected from the group consisting of polarization mode separator, polarization rotator, optical isolator, optical circulator, optical fiber, polarization maintaining fiber and polarization controller.